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Microbial Induced Calcite Precipitation (MICP) in Stabilizing Expansive Soils

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MICROBIAL INDUCED CALCITE PRECIPITATION (MICP) IN STABILIZING EXPANSIVE SOILS

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FIELD IMPLEMENTATION OF MICROBIAL INDUCED CALCITE PRECIPITATION

BACKGROUND

- Expansive soils undergo vast changes in volume when subject to change in water content and cause damage to civil structures.

Image source: caternews.com

Differential settlement in foundation of a house built on expansive soil


Image source: margopare.blogspot.com

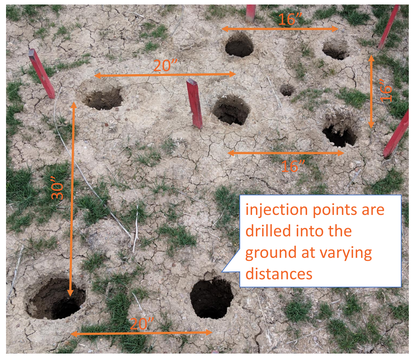
Cracks seen on a pavement surface built on expansive soil

- Traditional methods to tackle expansive soils involve adding cement or lime to the soil, which are not the most environmentally friendly solutions.
- Studies have shown that urease producing bacteria, which are naturally found in expansive soils, are capable of producing calcite ($CaCO_3$) in the soil.
- Laboratory tests done with natural clays in the SuRGE lab at Boise State University showed that MICP can significantly improve strength and reduce swelling of expansive soils.
- MICP in a natural soil could be achieved using injections of enrichment solution - to help bacterial growth, and cementation solution - to induce precipitation of calcite.

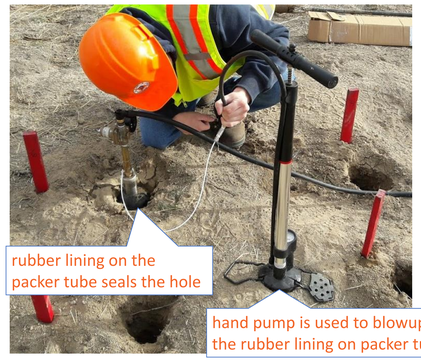
OBJECTIVES

- To understand the feasibility of microbial induced calcite precipitation in field.
- To study the effects of enrichment and cementation injections through calcite content and swelling potential.

INJECTION METHOD



- 2” diameter holes were drilled into the ground up to a depth of 4 feet.
- Two grids were used to inject solutions into the ground.



- A pneumatic packer tube was inserted into the injection point to seal and prevent the leakage of solution on the surface

- Solutions were injected through the packer into the ground at a pressure of 20 psi.

- Total of 22 gallons of the solution was injected (4-6 gallons per each injection point)

INJECTED SOLUTION

Enrichment solution – To help bacterial growth in soil

(Urea 20 gm/ltr, Sodium Acetate Anhydrous 8.2 gm/ltr, Solulys 0.5 gm/ltr)

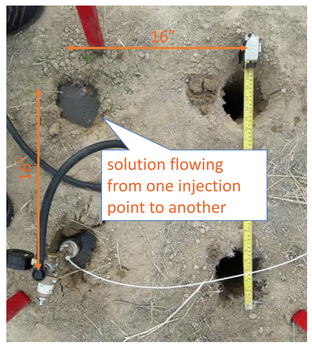
Cementation solution – To induce precipitation of calcite

(Calcium Chloride 27.74 gm/ltr, Urea 20 gm/ltr, Sodium Acetate Anhydrous 4.1 gm/ltr, Solulys 0.5 gm/ltr)

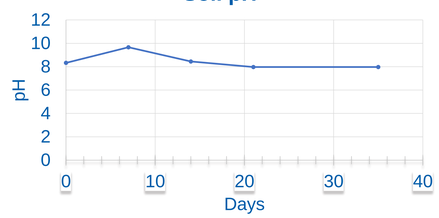
INJECTION TIMELINE

- Day 0 – Enrichment Solution
- Day 7 – Cementation Solution 1
- Day 14 – Cementation Solution 2
- Day 21 – Cementation Solution 3
- Day 35 – Cementation Solution 4

FIELD OBSERVATION

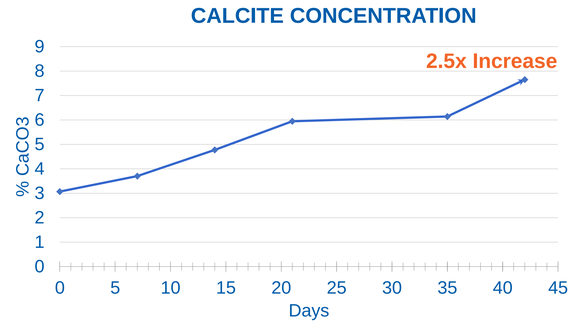


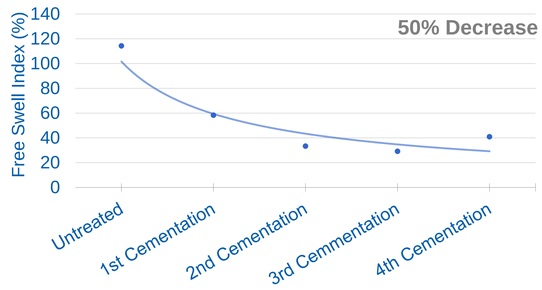
- Flow of solution was seen into neighboring injection points within distance of 16 inches.
- This indicates lateral flow of solution up to at least 16 inches.



- The initial increase in pH level indicates presence of urease producing bacteria are active.

RESULTS





CONCLUSION

- The calcite content increased significantly with each successive injection of cementation solution and reduced swelling potential.
- Microbial induced calcite precipitation can be successfully replicated in the field through successive injections of enrichment and cementation solutions into the soil.

ACKNOWLEDGEMENTS

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